WHAT IS CLAIMED IS:

1. A method for inducing a response in a long-lived electrochemical device which comprises the steps of: contacting a conjugated polymer working electrode and a counter electrode with an ionic liquid having an anion and a cation; and applying a voltage between the working electrode and the counter electrode, whereby the response is induced in the long-lived electrochemical device.

2. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the ionic liquid is stable in the presence of water and wherein the conjugated polymer is stable in the presence of the ionic liquid.

3. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the ionic liquid is stable for voltages applied between the conjugated polymer electrode and the second electrode in the range from – 3 V to + 3 V relative to a standard hydrogen electrode.

4. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the ionic liquid comprises a mixture of ionic liquids.

5. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the ionic liquid comprises at least one ionic solid dissolved in a nonaqueous solvent where the resulting solution being mixed with another ionic liquid.

6. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the anion comprises a weakly coordinating anion.

7. The method for inducing a response in a long-lived electrochemical device as described in claim 6, wherein the anion is selected from the group consisting of F^-; Br^-; I^-; NO_3^-; $N(CN)_2^-$; RSO_3^- where R is an alkyl group, substituted alkyl group, or phenyl group; $(CF_3)_2PF_4^-$, $(CF_3)_3PF_3^-$, $(CF_3)_4PF_2^-$, $(CF_3)_5PF^-$, $(CF_3)_6P^-$, $(CF_2SO_3^-)_2$,

$(CF_2CF_2SO_3^-)_2$, $(CF_3SO_2)_2N^-$, $CF_3CF_2(CF_3)_2CO^-$, $(CF_3SO_2)_2CH^-$, $(SF_5)_3C^-$, $(CF_3SO_2)_3C^-$, $[O(CF_3)_2C_2(CF_3)_2O]_2PO^-$, and $CF_3(CF_2)_7SO_3^-$.

8. The method for inducing a response in a long-lived electrochemical device as described in claim 6, wherein the anion comprises a small, weakly coordinating anion.

9. The method for inducing a response in a long-lived electrochemical device as described in claim 8, wherein the anion is selected from the group consisting of F^-; Cl^-; I^-; Br^-; NO_3^-; BF_4^-; ClO_4^-; PF_6^-; RSO_3^-; and $RCOO^-$, where R is an alkyl group, substituted alkyl group, or phenyl group.

10. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the cation is selected from the group consisting of pyridinium ions, pyridazinium ions, pyrimidinium ions, pyrazinium ions, imidazolium ions, pyrazolium ions, thiazolium ions, oxazolium ions, triazolium ions, ammonium ions, pyrrolidinium ions, pyrrolinium ions, pyrrolium ions, and piperidinium ions.

11. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the conjugated polymer is selected from the group consisting of polyphenylene, polyphenylenevinylene, polyphenylenesulfide, polyfluorene, poly(p-pyridine), poly(p-pyridalvinylene), polypyrrole, polyaniline, polythiophene, polythiophenevinylene, polyfuran, polyacetylene, and derivatives thereof.

12. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the conjugated polymer comprises a copolymer selected from the group consisting of phenylene, phenylenevinylene, phenylenesulfide, fluorene, p-pyridine, p-pyridalvinylene, pyrrole, aniline, thiophene, thiophenevinylene, furan, acetylene, and derivatives thereof.

13. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the conjugated polymer comprises an oligomer selected from the group consisting of phenylene, phenylenevinylene, phenylenesulfide, fluorene, p-pyridine, p-pyridalvinylene, pyrrole, aniline, thiophene, thiophenevinylene, furan, acetylene, and derivatives thereof.

14. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the ionic liquid further comprises an organic cosolvent.

15. The method for inducing a response in a long-lived electrochemical device as described in claim 14, wherein the organic cosolvent is selected from the group consisting of cyclic ethers, esters, carbonates, lactones, nitriles, amides, sulfones, and sulfolanes.

16. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the electrochemical device comprises an actuator, the response comprises a change in stress and strain of the actuator, and the counter electrode comprises a metal electrode.

17. The method for inducing a response in a long-lived electrochemical device as described in claim 16, wherein the counter electrode comprises a conjugated polymer electrode.

18. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the electrochemical device comprises a capacitor, the response comprises storing a charge on the capacitor and the counter electrode comprises a conjugated polymer electrode.

19. The method for inducing a response in a long-lived electrochemical device as described in claim 18, wherein the conjugated polymer electrodes comprise porous conjugated polymer films having a conducting metal coating on the side thereof facing away from the ionic liquid.

20. The method for inducing a response in a long-lived electrochemical device as described in claim 18, wherein the conjugated polymer electrodes comprise conjugated polymer films electrochemically synthesized using the ionic liquid and having a conducting metal coating on the side thereof facing away from the ionic liquid.

21. The method for inducing a response in a long-lived electrochemical device as described in claim 1, wherein the device comprises a rechargeable battery, the response comprises storing and deriving electrical energy from the battery and the working electrode comprises a metal electrode having a redox potential lower than the redox potential for the conjugated polymer electrode.

22. The method for inducing a response in a long-lived electrochemical device as described in claim 21, wherein said metal electrode comprises lithium.

23. The method for inducing a response in a long-lived electrochemical device as described in claim 21, wherein the conjugated polymer electrode comprises a porous conjugated polymer film having a conducting metal coating on the side thereof facing away from the ionic liquid.

24. The method for inducing a response in a long-lived electrochemical device as described in claim 21, wherein the conjugated polymer electrode comprises a porous conjugated polymer film electrochemically synthesized using the ionic liquid and having a conducting metal coating on the side thereof facing away from the ionic liquid.

25. A long-lived electrochemical device comprising in combination:

(a) a conjugated polymer working electrode;

(b) a counter electrode;

(c) an ionic liquid having an anion and a cation in contact with both said working electrode and said counter electrode; and

(d) an electronic power supply for applying a voltage between said working electrode and said counter electrode, whereby a response is induced in said electrochemical device.

26. The long-lived electrochemical device as described in claim 25, wherein said ionic liquid is stable in the presence of water and wherein said conjugated polymer is stable in the presence of said ionic liquid.

27. The long-lived electrochemical device as described in claim 25, wherein said ionic liquid is stable for voltages applied between said working electrode and said counter electrode in the range from – 3 V to + 3 V relative to a standard hydrogen electrode.

28. The long-lived electrochemical device as described in claim 25, wherein said ionic liquid comprises a mixture of ionic liquids.

29. The long-lived electrochemical device as described in claim 25, wherein the ionic liquid comprises at least one ionic solid dissolved in a nonaqueous solvent, where the resulting solution is mixed with another ionic liquid.

30. The long-lived electrochemical device as described in claim 25, wherein the anion comprises a weakly coordinating anion.

31. The long-lived electrochemical device as described in claim 30, wherein the anion is selected from the group consisting of F^-; Br^-; I^-; NO_3^-; $N(CN)_2^-$; RSO_3^- where R is an alkyl group, substituted alkyl group, or phenyl group; $(CF_3)_2PF_4^-$, $(CF_3)_3PF_3^-$, $(CF_3)_4PF_2^-$, $(CF_3)_5PF^-$, $(CF_3)_6P^-$, $(CF_2SO_3^-)_2$, $(CF_2CF_2SO_3^-)_2$, $(CF_3SO_2)_2N^-$, $CF_3CF_2(CF_3)_2CO^-$, $(CF_3SO_2)_2CH^-$, $(SF_5)_3C^-$, $(CF_3SO_2)_3C^-$, $[O(CF_3)_2C_2(CF_3)_2O]_2PO^-$, and $CF_3(CF_2)_7SO_3^-$.

32. The long-lived electrochemical device as described in claim 30, wherein the anion comprises a small, weakly coordinating anion.

33. The method for inducing a response in a long-lived electrochemical device as described in claim 8, wherein the anion is selected from the group consisting of F^-; Cl^-; I^-; Br^-; NO_3^-; BF_4^-; ClO_4^-; PF_6^-; RSO_3^-; and $RCOO^-$, where R is an alkyl group, substituted alkyl group, or phenyl group.

34. The long-lived electrochemical device as described in claim 25, wherein the cation is selected from the group consisting of pyridinium ions, pyridazinium ions, pyrimidinium ions, pyrazinium ions, imidazolium ions, pyrazolium ions, thiazolium ions, oxazolium ions, triazolium ions, ammonium ions, pyrrolidinium ions, pyrrolinium ions, pyrrolium ions, and piperidinium ions.

35. The long-lived electrochemical device as described in claim 25, wherein said conjugated polymer is selected from the group consisting of polyphenylene, polyphenylenevinylene, polyphenylenesulfide, polyfluorene, poly(p-pyridine), poly(p-pyridalvinylene), polypyrrole, polyaniline, polythiophene, polythiophenevinylene, polyfuran, polyacetylene, and derivatives thereof.

36. The long-lived electrochemical device as described in claim 25, wherein said conjugated polymer comprises a copolymer selected from the group consisting of phenylene, phenylenevinylene, phenylenesulfide, fluorene, p-pyridine, p-pyridalvinylene, pyrrole, aniline, thiophene, thiophenevinylene, furan, acetylene, and derivatives thereof.

37. The long-lived electrochemical device as described in claim 25, wherein said conjugated polymer comprises an oligomer selected from the group consisting of phenylene, phenylenevinylene, phenylenesulfide, fluorene, p-pyridine, p-pyridalvinylene, pyrrole, aniline, thiophene, thiophenevinylene, furan, acetylene, and derivatives thereof.

38. The long-lived electrochemical device as described in claim 25, wherein said ionic liquid further comprises an organic cosolvent.

39. The long-lived electrochemical device as described in claim 38, wherein said organic cosolvent is selected from the group consisting of cyclic ethers, esters, carbonates, lactones, nitriles, amides, sulfones, and sulfolanes.

40. The long-lived electrochemical device as described in claim 25, wherein said electrochemical device comprises an actuator, the induced response comprises a change in stress and strain of the actuator and said counter electrode comprises a metal electrode.

41. The long-lived electrochemical device as described in claim 40, wherein said counter electrode comprises a conjugated polymer electrode.

42. The long-lived electrochemical device as described in claim 25, wherein said device comprises a capacitor, said induced response comprises storing an electric charge on said capacitor and said counter electrode comprises a conjugated polymer electrode.

43. The long-lived electrochemical device as described in claim 42, wherein said conjugated polymer electrodes comprise porous conjugated polymer films having a conducting metal coating on the side thereof facing away from said ionic liquid.

44. The long-lived electrochemical device as described in claim 42, wherein said conjugated polymer electrodes comprise porous conjugated polymer films electrochemically synthesized using the ionic liquid and having a conducting metal coating on the side thereof facing away from the ionic liquid.

45. The long-lived electrochemical device as described in claim 25, wherein said device comprises a rechargeable battery, said induced response comprises storing and deriving electrical energy from said battery and said counter electrode comprises a metal electrode having a redox potential lower than the redox potential for the conjugated polymer electrode.

46. The long-lived electrochemical device as described in claim 45, wherein said metal electrode comprises lithium.

47. The long-lived electrochemical device as described in claim 45, wherein said conjugated polymer electrode comprises a porous conjugated polymer film having a conducting metal coating on the side thereof facing away from said ionic liquid.

48. The long-lived electrochemical device as described in claim 45, wherein said conjugated polymer electrode comprises a porous conjugated polymer film electrochemically synthesized using the ionic liquid and having a conducting metal coating on the side thereof facing away from the ionic liquid.